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A Comparative study of Functional Outcomes, And Complications of Total Knee Replacement in Post-Traumatic Osteoarthritis V/S Primary Knee Osteoarthritis.

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Abstract

Background: Post-traumatic osteoarthritis (PTOA) occurs after fracture-related trauma around the knee or in the case of ligamentous injuries, and is a significant contributor to pain, stiffness and functional disability. Primary OA (Primary osteoarthritis), however, is a degenerative joint disease that tends to affect the elderly and is not associated with a preceding traumatic event. Although end-stage osteoarthritis is an indication for total knee replacement (TKR), patients with PTOA may experience a different outcome from those patients with Primary OA because of differences in patient characteristics, prior knee trauma, complexity of surgery, and other comorbidities. While there are international studies that compare outcomes of these groups, few local studies are available on functional recovery following TKR in Pakistan.

Objective: To compare objective postoperative outcomes (pain, stiffness, physical function and total WOMAC score) of patients with PTOA and primary osteoarthritis who undergo TKA.

Methods: The methodology of this comparative study will be done in Orthopaedic Department of the selected tertiary care hospital. Patients with post-traumatic osteoarthritis and primary osteoarthritis who are undergoing primary total knee replacement, will be recruited in accordance with the inclusion and exclusion criteria. Participants will be split into two groups – Group A (Post-Traumatic Osteoarthritis) and Group B (Primary Osteoarthritis). A structured data collection form will be used to capture demographic data and clinical variables. Functional outcomes will be evaluated by the WOMAC (Western Ontario and McMaster Universities Osteoarthritis Index) with its pain, stiffness and physical function sub scores and the Visual Analogue Scale (VAS) for pain. SPSS 27 will be used for data analysis. Independent t-test will be used to compare continuous variables and Chi-Square test will be used to compare categorical variables. Statistically significant differences will be indicated by a p-value <0.05.

Results: Primary OA patients are expected to show superior functional outcome after surgery than PT OA patients. PTOA patients can be expected to have somewhat poorer WOMAC pain, stiffness and functional scores, because of previous trauma sustained by the joint and increased surgical complexity. But there is likely to be a substantial functional improvement in both groups after total knee replacement.

Conclusion: KA is likely to result in substantial benefits in terms of reduction in pain and functional status in both post-traumatic and primary osteoarthritis patients. But functional recovery may be relatively poor in patients with post-traumatic osteoarthritis as compared to those with primary osteoarthritis. The results of this study will yield local data on postoperative functional results and could help orthopedic surgeons in their counseling and planning of surgical procedures as well as postoperative rehabilitation.

Introduction

Osteoarthritis is a chronic, progressive musculoskeletal disorder in which there is structural and functional change in synovial joints. The disease was once thought to be primarily the result of the deterioration of the articular cartilage, but is now considered to be a problem of the whole joint. Pathological changes include cartilage degeneration, subchondral bone remodeling, osteophytes, synovial inflammation, meniscal damage,

ligament dysfunction and muscle weakness. These changes gradually affect the biomechanics of these joints and result in pain, stiffness, deformity, decreased mobility, and restrictions in activities of daily living. The knee is one of the most commonly involved joints since it is constantly subjected to mechanical stresses during standing, walking, ascension and descent of stairs, squatting, kneeling and work-related tasks [1].
There are two main types of osteoarthritis of the knee: primary and secondary. Primary knee OA occurs in the absence of a known initiating event and has been linked to ageing, genetic predisposition, obesity, female sex, metabolic disorders, repetitive mechanical stresses, muscle weakness and lower limb malalignment. It is a slowly developing disease, typically taking several years. Secondary osteoarthritis on the other hand, is a result of a known underlying disease like inflammatory arthritis, infection, congenital deformity, osteonecrosis, metabolic disease, or previous joint trauma. Post-traumatic osteoarthritis is an important form of secondary osteoarthritis as it often occurs at a younger, more physically active age in life [1,2].
Post-traumatic OA is caused by an acute or repetitive injury to the joint. Past trauma has been estimated to account for a significant number of cases of symptomatic OA, and is one of the most important risk factors for lifelong musculoskeletal disability [2]. The knee can be injured in road traffic collisions, sports, falls, industrial accidents, military service or physically demanding occupations. Whereas primary OA often develops slowly in the elderly, post-traumatic OA can start with a known injury, and can occur over a shorter time course. It can, therefore, lead to significant physical, social and economic consequences, especially if the condition occurs in younger people who are the breadwinners and the ones involved in the activities of the family.
Many different types of injuries can lead to post-traumatic knee osteoarthritis. These encompass tibial plateau, distal femur, patellar, anterior cruciate ligament, posterior cruciate ligament, collateral ligament, meniscal tears, knee dislocation and complex multifilament injuries. Intra-articular fractures are especially significant as they can have a direct effect on the articular cartilage and affect the congruity of the joint surface. Long-term follow-up studies have shown that even though the tibial plateau fracture is healed and the surgical procedure is appropriate, patients with the tibial plateau fracture or another intra-articular lesion around the knee might develop degenerative joint disease [3-5].
Mechanical and biological factors play a role in the development of post-traumatic osteoarthritis. Direct impact at time of the injury can cause damage to the chondrocytes, damage to the cartilage matrix, subchondral bone injury and bleeding within the joint. Intra-articular fractures can result in irregularity at the joint surface, and malunion may result in varus or valgus deformity. Rupture of ligaments can result in instability and damage to menisci can decrease the load distribution of the joint. These abnormalities lead to higher contact pressure at specific regions of cartilage, and to a higher mechanical load on the joint during normal activities [2-5].
Trauma also triggers an inflammation in the knee. There is the release of inflammatory mediators and matrix-degrading enzymes from damaged cartilage, bone, menisci and synovial tissues. These biological agents can promote degradation of cartilage and decrease the ability of chondrocytes to synthesize the extracellular matrix. Inflammation can persist after treatment of the initial injury, and can continue to occur over time, causing degeneration. Therefore, the restoration of the fracture alignment or the stability of the ligaments does not necessarily prevent the subsequent development of osteoarthritis as some of the biological and structural damage has already taken place at the time of the fracture.
Risk for development of post-traumatic osteoarthritis depends on the nature and extent of the trauma. It is higher with intra-articular fracture, presence of residual joint incongruity, malalignment, joint instability, large amount of cartilage damage, meniscal deficiency, infection, and multiple prior surgeries. Other factors such as age, BMI, activity level and quality of fracture reduction may also have an impact on the

progression of the disease. Patients with tibial plateau fractures who have an operative fixation are still more likely to later require a total knee arthroplasty than people who never sustained a tibial plateau fracture [6].

Although the underlying mechanisms are different, in advanced stages, primary and post-traumatic osteoarthritis can present with the same clinical features. Patients typically complain of pain with activities like walking, stairs, prolonged standing and getting up from a chair. If you have early stages of the condition, your pain might be occasional, and come and go, particularly following exercise. As the disease progresses, symptoms may be constant, happen when the person is at rest and interfere with sleep. Other clinical manifestations are morning stiffness, crepitus, swelling, loss of range of motion, weakness of quadriceps, instability, flexion contracture and varus or valgus deformity.

As knee arthritis progresses, an individual may become very limited physically. Difficulty walking long distances, going up and down stairs, kneeling and squatting, doing household chores, travelling and staying at work. Deconditioning with the heart and vascular system, weight gain, social isolation, anxiety and depression can be a result of reduced mobility. The overall burden of disease is thus not limited to knee pain and can include psychological, family, occupational productivity and quality of life.

Diagnosis is based on clinical history and physical examination and radiographic findings. Common features on standard weight-bearing radiographs include joint-space narrowing, osteophyte formation, subchondral sclerosis, cyst formation, and deformity. In post-traumatic cases, imaging may also show fracture malunion, retained implants, areas of bone defect, prior reconstruction tunnels, or changes in mechanics. But there is not always a direct relationship between radiographic severity and pain or functional disability. For this reason, as well as objective clinical findings, patient-reported outcome measures should be taken into consideration when assessing the severity of the disease and its response to treatment.

The decision for treatment in Knee OA is usually based on the following factors: severity of the symptoms, radiographic changes, functional impairment, age, co-morbidities and patient expectations. Helping the patient to learn, lose weight, modify activity, physiotherapy, strengthening exercises, walking devices, bracing and shoes are all common initial treatment options. Topical and oral non-steroidal anti-inflammatory drugs and other analgesics might be used as pharmacological treatment. Patients with very limited symptoms may get some relief with intraarticular corticosteroid or hyaluronic acid injection.

Conservative management can help to alleviate pain and improve function but will not stop the progressive cartilage loss if it is widespread. Patients with post-traumatic disease may require additional treatment including removal of implants, ligament reconstruction, arthroscopic surgery, corrective osteotomy or cartilage preserving surgery. But when there is already significant joint degeneration and pain, deformity and loss of function these procedures may not be helpful over the long term. If non-operative techniques do not help, joint replacement may be needed.

Total knee replacement (total knee arthroplasty) is a well proven surgical treatment for end-stage knee osteoarthritis. It entails the removal of the damaged articular surfaces from the distal femur and proximal tibia and their replacement by prostheses. Sometimes, the surgeon may resurface the patella based on his assessment and institutional practice. The main goals of TKA surgery are to eliminate pain, realign the knee, stabilize the knee, increase mobility, and help the patient be more independent in day-to-day activities.

Total knee replacement for primary OA is carried out in a fairly predictable anatomical environment. Patients can have deformity, flexion contracture and ligament imbalance, but the normal surgical technique and conventional implant systems usually suffice. Total knee replacement for post-traumatic osteoarthritis can be significantly more complex as the anatomy may be distorted from the original trauma and surgery. [7]

The potential complications of fracture-related post-traumatic osteoarthritis include malunion, nonunion, intra-articular bone loss, extra-articular deformities, retained fixation devices, multiple surgical scars, and poor soft-tissue coverage. These factors may contribute to challenges in surgical exposure, bone resection, component placement and ligament balancing. Hardware can interfere with alignment instrumentation and/or placement of implants and may require removal prior to or during arthroplasty. For significant bone defect, grafting, metal augments, stemmed components and more limited designs of the prostheses may be required [7-9].

Past incisions and soft-tissue damage also must be taken into consideration. The presence of multiple scars can raise the risks of wound-healing complications; vascularity defects can lead to wound infection and/or skin necrosis. Exposure may be hampered by profound stiffness and there is a risk of injury to the extensor mechanism. Conventional intramedullary guides may be impossible to use, and corrective osteotomy may be needed in some cases, for extra-articular deformity.

Post-traumatic OA associated with ligament problems could pose unique surgical issues. Previous cruciate ligament surgery along with previous multi-ligament surgery may include chronic instability, altered tibial translation, rotational abnormalities, reconstruction tunnels, retained screws, and previous graft harvest sites. But the number of major bone defects may be lower in these patients as compared to patients with preexisting periarticular fractures. The post-traumatic OA can arise from a fracture or from a ligamentous injury, which means outcomes following arthroplasty could vary between these two different scenarios.

The literature has shown that TKA can give significant reduction in pain and functional improvement in patients with PTOA. However, results may not be as predictable as in patients with primary osteoarthritis. Others have documented reduced postoperative function, decreased quality of life, increased postoperative stiffness, and decreased implant survival in the patients with post trauma [10]. Other studies have reported extended operating times and increased surgical resources due to the changes of anatomy, presence of implants and complicated reconstruction [7].

There may also be differences between the complication rates for the two groups. Patients with post-traumatic arthritis have been shown in large comparative studies to have a higher risk of wound complications, infection, stiffness, instability, and revision surgery [11,12]. The risk might be influenced by the nature of the original trauma, prior surgical procedures, soft tissue status, history of retained implants, and length of follow-up. But results are not entirely uniform: other studies report similar short- or medium-term results in certain sub-groups of post-traumatic and primary osteoarthritis.

Differences in outcome may be due to patient characteristics. Patients with post-traumatic osteoarthritis tend to be younger with fewer systemic comorbidities than patients with primary osteoarthritis. However, they are likely to be more anatomically complex locally and have higher functional demands. Patients with primary osteoarthritis tend to be older and may have age-related diseases that affect rehabilitation, such as obesity, cardiovascular disease, or diabetes. Hence, postoperative results should not only be seen in the light of the underlying etiology of OA but also understood in the context of the pre-existing level of function, age, comorbidity, deformity and surgical complexity.

One of the main reasons for undergoing total knee replacement is pain. A Visual Analogue Scale is often used to measure pain pre and post-surgery. It offers a convenient numerical definition of patients' perceived pain and enables the degree of postoperative improvement to be measured. But pain scores are not the only measure of knee function. This patient may have a lot less pain, but he may still have stiffness, weakness or struggle with daily activities.

Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a popular patient-reported outcome measure of symptoms and functional limitations in people with hip or knee osteoarthritis. It measures three components: pain, stiffness and

physical function [13]. The functional aspect evaluates problems with walking, walking upstairs, standing, sitting, getting up from a chair, and doing everyday activities. The instrument is well validated and widely used to determine treatment effectiveness in clinical trials of subjects with osteoarthritis and joint replacement surgery [13,14].

VAS and WOMAC scores are useful indicators of the efficacy of total knee replacement, when compared with preoperative and postoperative scores. Preoperative scores are used to describe how severe the symptoms are prior to undergoing an operation, while postoperative scores are used to describe how the patient is after surgery. Improvement scores represent the extent of change that each patient has made. This is significant because two groups can score the same amount but improve by different amounts or score different amounts and have similar postoperative results.

Another important factor after total knee replacement is mechanical alignment. The idea behind the traditional mechanical alignment methods is to return the lower limb as near as possible to a neutral mechanical axis. Malalignment has historically been linked with unequal load distribution, component wear, instability and loosening. But the correlation of minor misalignment deviations and long-term implant survival is still controversial. There are some long-term studies showing that in all patients, implants with a neutral range alignment cannot be correlated with a better implant survival [15,16].

Satisfactory alignment can be challenging in post-traumatic osteoarthritis due to fracture malunion, extra-articular deformity, bone loss, prior osteotomy, or presence of retained implants. New technologies like computer navigation, patient-specific instruments and robot-assisted surgery can be used to help improve component positioning in complex cases. However, functional outcome is influenced by various other factors such as ligament balance, component rotation, restoration of the joint-line, soft-tissue condition, rehabilitation, and patient-related characteristics.

In the comparative study that was uploaded there were patients with primary osteoarthritis, patients with post-traumatic osteoarthritis due to fracture, and patients with post-traumatic osteoarthritis due to ligament. Patients in the post-traumatic group were significantly younger and had a higher male to female ratio and patients with primary osteoarthritis had a higher number of comorbidities. The fracture related and ligamentous post-traumatic groups had longer operating times than the primary OA group [1].

A similar study reported that postoperative pain and stiffness was worse in the fracture-related post-traumatic group compared with the primary osteoarthritis group. However, no significant difference was found between ligamentous post-traumatic osteoarthritis and primary osteoarthritis for the WOMAC components [1]. These suggest that post-traumatic osteoarthritis (PTOA) should not be assumed to be a single entity as the complexity of the total knee replacement (TKR) procedure and its outcome may be determined by the type of previous injury.

Total knee replacement use is growing, but evidence is still mixed regarding the outcomes of patients with post-traumatic versus primary osteoarthritis. Small post-traumatic sample size, the mixing of different types of injuries, and emphasis on complications and implant survival have been experienced in many previous studies. There are few studies that make direct comparisons of preoperative pain, postoperative pain, functional status and improvement using standardized outcome instruments. International findings may also not be generalizable to local populations due to differences in healthcare systems, patient characteristics, rehabilitation services, injury patterns and surgical techniques.

A comparison of the two groups of patients with primary and post-traumatic OA who underwent total knee replacement is therefore clinically important. This comparison could assist surgeons in realistic pre-operative counselling and prepare them for technical difficulties, choose the correct implant and even identify patients who may need to undergo more extensive rehabilitation. It could also help to determine if there

is a link between the underlying cause of the OA and how much pain relief and functional recovery is achieved following surgery.
The aim of the present study is to compare therefore the clinical and functional results of TKA performed for patients with knee OA due to post-traumatic or primary cause. The Visual Analogue Scale is used to assess the severity of the pain, and the Western Ontario and McMaster Universities Osteoarthritis Index is used to assess pain, stiffness and physical function. This study will compare the scores before and after total knee replacement and the improvement between the two groups to see if the aetiology of knee osteoarthritis affects the outcome of total knee replacement. The results can help to improve patient selection, surgical planning, pre-operative counselling, post-operative rehabilitation and expectations of recovery.

Literature review

Osteoarthritis (OA) is a degenerative condition of synovial joints, and is one of the most common causes of chronic pain, decreased mobility, physical disability and diminished quality of life in adults. Previously thought of as a disease of the articular cartilage only, it is now acknowledged as a joint disease. It is characterized by the following pathological changes: progressive cartilage loss, subchondral bone sclerosis and remodelling, osteophyte formation, synovial inflammation, degeneration of the menisci and ligaments, and weakness of the muscles around the affected joint. The structural changes cause disruption of the normal joint mechanics and eventually lead to pain, stiffness, deformity, lack of motion and function [1,2].
The knee is especially susceptible to osteoarthritis as it is a weight bearing joint and is subjected to repeated mechanical forces during standing, walking, stair climbing, squatting, kneeling and running. The load that passes down the knee is even greater in people with obesity, lower limb malalignment, muscle weakness, and in jobs that require repetitious physical activity. There have been a significant rise in the prevalence of knee OA, related to population ageing, longer life expectancy, obesity, and sedentary lifestyles. It is now an important public-health and socioeconomic issue because of its association with frequent health-care visits, long-term medication use, decreased work productivity, loss of independence and an increasing need for joint replacement surgery [1,2].
There are two types of knee osteoarthritis – primary and secondary. Primary OA is a disease that does not have a single initiating event and is linked to old age, genetic predisposition, obesity, female sex, metabolic disturbances, muscle weakness, repetitive joint loading, and lower limb deformities. It typically occurs over years of time with the deterioration of the joint tissues' ability to withstand mechanical stress, particularly articular cartilage. Secondary OA is caused by a known underlying condition such as inflammatory arthritis, infection, congenital or developmental deformity, osteonecrosis, metabolic disease or prior joint trauma. While both primary and secondary OA can lead to the same clinical and radiographic changes, they differ in onset, rates of progression, patient factors, bony abnormalities and the treatment needed.
Post-traumatic osteoarthritis (PTOA), which occurs as a result of an acute or repetitive traumatic insult to a joint, is an important form of secondary OA. Previous trauma is thought to be responsible for about 12% of symptomatic OAs, showing that trauma plays a significant role in the burden of any degenerative joint disease [3]. While primary OA more often occurs in older people, PTOA often occurs in younger and physically active people. It can therefore lead to disability at a time of life when patients should be engaged in work, family and social life.
Post-traumatic osteoarthritis of the knee can be found after fractures of the tibial tuberosity or distal femur, anterior cruciate ligament (ACL) injury, posterior cruciate ligament (PCL) injury, collateral ligament injury, meniscal tears, patellar trauma, knee dislocations, and multiligament injuries. The injuries can result from falls, work-related

accidents, sports, military service, or road traffic accidents. Risk factors for the development of PTOA include the type and severity of the initial trauma, amount of cartilage destruction, persistent incongruity, instability, malalignment, loss of meniscal support, weight and prior surgeries.

Intra-articular fractures are especially linked to later degenerative changes as it directly causes damage to the articular cartilage and the subchondral bone. Even if the fracture is fixed well, the joint surface may have small irregularities, which can affect the force on the joint surface when the weight is put on the leg, and which may lead to increased contact stresses. Degenerative changes after tibial plateau fractures and other intra-articular fractures around the knee have been shown with long-term studies [4,5]. Additionally, patients treated operatively for tibial plateau fractures can continue to have pain, decreased motion and dysfunction years after union.

Major periarticular trauma is a risk factor for total knee replacement. It has been reported in the literature that patients who had an operative procedure for tibial plateau fractures had an increased risk for subsequent total knee arthroplasty (TKA) in comparison with the matched patients without tibial plateau fractures [7]. This means that if the fracture heals well, this does not necessarily prevent the onset of end stage osteoarthritis. Bone may unite and function may return to normal, but damage in the articular cartilage, menisci, ligaments, subchondral bone, and synovial tissues can still have an impact on the joint's health for many years.

Additionally, ligamentous and meniscal injuries can also play a part in the development of PTOA as these affect the stability and load distribution of the knee. Anterior cruciate ligament rupture can result in abnormal anterior tibial translation and abnormal rotational motion. Meniscal injury or meniscectomy will diminish the capacity for the knee to spread out the load evenly over all of the joint surfaces and will increase the pressure on the remaining cartilage. While sometimes the damage to the cartilage and subchondral bone from the initial injury cannot be fixed, ligament reconstruction can restore stability and improve function. Therefore, degenerative changes can persist even after successful ligament reconstruction surgery has been performed.

PTOA is the result of acute mechanical damage combined with chronic biological inflammation. Direct impact at the time of injury can lead to chondrocyte death, disruption of collagen fibres, loss of cartilage matrix components, subchondral bone injury and bleeding in the joint. These are immediate changes that decrease cartilage's ability to withstand compressive and shear forces. The primary trauma can also create instability, malalignment or incongruity of the articular surface, adding to the abnormal mechanical loading.

In the inflammatory phase, the damaged cartilage, bone, menisci, and synovial tissues produce cytokines, prostaglandins, chemokines, and matrix-degrading enzymes. Interleukin-1β and tumour necrosis factor-α induce the synthesis of matrix metalloproteinases and other enzymes which degrade collagen and proteoglycans. At the same time, the ability of chondrocytes to repair and maintain the extracellular matrix becomes impaired. Synovial inflammation can thus perpetuate the degenerative process well after the underlying mechanical insult has been addressed [8].

Inflammation then over time acts in combination with abnormal joint biomechanics. Specific areas of the knee are at risk for excessive/repetitive loading with the presence of residual articular depression, fracture malunion, lower-limb malalignment, ligament instability, meniscal deficiency, or muscle weakness. Mechanical stress leads to more cartilage loss, subchondral bone remodelling, osteophytes, and pain, stiffness, and deformity. As such, PTOA is not just a delayed effect of an imperfect fracture reduction, but is a progressive disorder involving mechanical, inflammatory and metabolic pathways.

PTOA has a different initiating mechanism than primary OA. Primary disease is normally a slow process of aging, obesity, repetitive mechanical stress, genetic predisposition and low grade inflammation. PTOA starts with a clear traumatic incident

that affects multiple joint structures and can cause more accelerated deterioration. Both however, eventually result in progressive cartilage destruction, synovitis, subchondral bone changes, osteophyte formation, pain and functional deterioration.

Patients with knee OA typically have pain, stiffness, swelling, crepitus, decreased range of motion, muscle weakness and difficulties with daily activities related to activity. Typically, pain is worsened by walking, standing, climbing stairs, sitting and squatting, and getting up from a chair or kneeling. In the early stages, there can be intermittent symptoms, which can be relieved by rest. Later in the disease, pain may be continuous, at rest and interfere with sleep.

Knee OA typically resolves the morning stiffness within 30 minutes, but if stiffness persists, it could be the result of an inflammatory joint condition. Physical examination can include findings of joint-line tenderness, bony enlargement, effusion, crepitus, decreased flexion and/or extension, instability, quadriceps wasting, and deformities of varus and/or valgus. Patients with PTOA can also have multiple surgical scars, retained implants, limb deformities, instability, significant stiffness, and limited motion from the original injury or surgeries.

Knee OA symptoms can greatly impair physical independence and the quality of life. Patients may have difficulty walking long distances, using stairs, sitting for long periods of time, kneeling, squatting, traveling, doing housework, or working. Limited mobility can also lead to obesity, cardiovascular deconditioning, social isolation, anxiety and depression. The consequences of the disease can thus go beyond the pain in the knees and can include psychological impact, social involvement, family duties and work productivity.

Diagnosis is made from history, physical examination and radiographs. Weight-bearing anterior-posterior and lateral X-rays, a patellofemoral view, and if necessary, a full-length standing X-ray, are standard imaging. Common features include joint-space narrowing, marginal osteophytes, subchondral sclerosis, cyst formation and deformity of the lower limbs. Radiographs may also show fracture malunion and/or articular depression, bone defects, retained fixation devices, prior ligament-reconstruction tunnels, and/or extra-articular deformity in post-traumatic cases.

The radiographic severity does not necessarily correlate with the amount of pain or disability that the patient experiences. That is why it is important to use patient-reported outcome measures when assessing the severity of the disease and its treatment. The Visual Analogue Scale is commonly used to measure the severity of pain and the Western Ontario and McMaster Universities Osteoarthritis Index measures pain, stiffness and physical function [16,17]. It's especially helpful to measure the challenges of walking, going up or down stairs, standing, sitting, getting up from a chair, and doing daily tasks with WOMAC.

Treatment for knee OA is determined by the severity of the symptoms, x-ray findings, degree of functional impairment, patient's age, other conditions, and expectations of treatment. Initially, patient education, weight loss, physical activity, muscle strengthening exercises, physiotherapy, activity modification, walking aids, knee braces and appropriate footwear are included. The aim of exercise programmes is to increase quadriceps strength, mobility of the joint, balance and physical capacity.

Topical and/or oral non-steroidal anti-inflammatory drugs and other analgesic therapy may be used. Intra-articular corticosteroid injections can help with pain in the short-term and HA injections (hyaluronic acid) are effective for some patients but not others. In general, it is recommended that a combination of non-pharmacological and pharmacological measures be used to treat patients, not one treatment measure alone [9].

Conservative treatment can help to alleviate symptoms and enhance function but can not fix severely damaged cartilage in the joint. Patients with PTOA may require further surgery including implant removal and/or arthroscopic surgery, ligament reconstruction, corrective osteotomy or cartilage-preserving surgery. Selected younger patients with

localised disease, instability or correctable deformity may benefit from these procedures. When there is great degeneration, pain, deformity and functional limitation, however, total knee replacement may be necessary.

For end-stage knee OA total knee replacement (TKR) or total knee arthroplasty (TKA) is an accepted treatment. The operation is performed by taking out the damaged articular surfaces of the tibia and femur, and substituting them with prosthetic components. Depending on the patient and the type of implant used, as well as the surgeon's preference, patellar resurfacing may also be performed. The goals of the procedure are to alleviate pain, straighten deformity, restore stability, correct alignment, and enhance mobility.

In general, total knee replacement will result in significant gains in pain, physical function and quality of life. Long-term data suggest that a high number of knee implants remain intact for over 15–20 years and pooled registry and case-series data have demonstrated that many may continue to function for 25 years [10]. However, implant design, component placement, ligament stability, patient age, BMI, co-morbidities, pre-operative function, rehab and the cause of arthritis can affect the postoperative outcome.

In most cases, a total knee replacement (TKA) is undertaken in a relatively predictable anatomical setting for primary OA. Patients can also present with varus/valgus deformity, flexion contracture, and ligament imbalance, but standard surgery and conventional prosthetic systems may be adequate. Planning for replacement for PTOA, on the other hand, might be more thorough, as the knee anatomy may have been greatly altered by the original trauma and surgery.

Fracture malunion, articular depression, bone loss, extra-articular deformity, retained plates or screws, ligament instability, multiple scars and compromised soft-tissue vascularity, can complicate surgical exposure, bone resection, component placement, and ligament balancing. Retained fixation devices may hinder intramedullary alignment devices or prosthetic parts. Therefore, hardware might be needed to be removed prior to knee replacement, or at the time of knee replacement.

A variety of treatment options, such as constrained prosthetic design, stemmed components, metallic augments, or bone grafting, may be necessary to address bone defects. If an extra-articular deformity is severe, corrective osteotomy may be needed in addition to arthroplasty. Previous incisions and poor soft-tissue coverage can create a potential for delayed healing, infection and skin necrosis. If the stiffness is severe, this will make surgical exposure more challenging and increase the risk of injury to the patellar tendon, quadriceps mechanism or collateral ligaments.

Dexel et al. found that the TKA for PTOA was more complex and utilized more surgical resources than primary OA [11]. Difficult exposure, removal of the implant, bone reconstruction, and extensive soft-tissue balancing could lead to longer surgery time. More complex surgery can also lead to more blood loss, longer hospital stay, slower recovery and complications after surgery.

The surgical difficulties may be different between fracture-related and ligament-related PTOA. The fracture-related disease is more likely to have bone defects, malunion, extra-articular deformities, retained fixation devices and pathology of soft tissues. Ligamentous PTOA may include instability, abnormal translation of tibia, rotational abnormality, reconstruction tunnels and retained screws, but may not have as much bone loss. These differences may help to account for the varying postoperative outcomes based on the type of previous trauma.

In the available literature, there are significant reports on the pain relief and functional improvement that TKR offers in both primary OA and PTOA. Outcomes in post-traumatic cases, however, are generally thought to be less predictable. Lunebourg et al. found lower function, quality of life and implant survival after TKR in post-traumatic arthritis than primary arthritis [13]. This is because of prior surgery, decreased mobility prior to surgery, atypical anatomy, scars, instability, and more complex surgery.

There have also been comparative studies that have focused on postoperative complications. Brockman et al. found that TJR for primary OA and PTA had different grades of complications [14]. Bala et al. also found that cases of post-traumatic may be more prone to wound complications and other complications [15]. However, results are not always consistent and some PTOA patients might get similar results as patients who had primary OA.

Phruetthiphat et al. compared 716 patients with primary OA, 32 with PTOA resulting from fractures and 104 with PTOA resulting from ligamentous damage [12]. The post-traumatic group was significantly younger and contained a higher percentage of men, while primary OA group contained a higher number of medical comorbidities. Fractures and ligament related PTOA groups had higher operative time compared with the primary OA group.

There were no significant differences in the preoperative WOMAC scores between the groups. After surgery, however, the patients in the fracture-related PTOA subgroup had worse WOMAC pain and stiffness scores than patients in the primary OA group. However, there was no difference in any of the WOMAC components between patients with ligament-related PTOA and patients with primary OA [12]. The results indicated that PTOA should not be considered as a homogeneous entity as the type of the initial lesion could affect the extent of surgery and postoperative rehabilitation.

The study did not show the 8-year survivorship free of aseptic loosening to differ significantly between the PTOA and primary OA group, although there were differences in functional outcomes. During the period of follow up reported, only one case of aseptic loosening was noted in the post-traumatic group versus none in the primary OA group. The authors concluded that outcomes were worse in the fracture-related PTOA, but similar in the primary OA and ligament-related PTOA [12].

Previous research has also shown that clinically significant improvements are possible in technically demanding post-traumatic patients. Improvement in knee scores and ROM was observed after TKR in patients with previous open reduction and internal fixation of tibial plateau fractures [18]. These results suggest that despite the complexity of the surgery, there can be a significant clinical improvement for patients with PTOA, but the final level of function may not be the same as for uncomplicated primary OA patients.

Mechanical alignment has traditionally been considered an important factor in the survival of total knee prostheses. The goal of the conventional techniques is to align the components to be within about 3° of a neutral mechanical axis in the lower limb. Theoretically malalignment can cause unequal load distribution, polyethylene wear, instability, loosening and early revision.

The association between mechanical alignment and long-term implant survival is, however, controversial. Parratte et al. did not demonstrate that implants that were aligned in the conventional neutral range would be associated with better 15-year implant survival [19]. Bonner et al in addition reported only restricted connection amongst postoperative mechanical alignment and long term prosthesis survival [20]. This means that the results of knee replacement are influenced by a number of interacting factors, and not mechanical alignment alone.

Satisfactory alignment can be challenging in PTOA due to fracture malunion, bone loss, prior osteotomy, extra-articular deformity, or hardware. Phruetthiphat et al. reported no correlation between postoperative alignment in the neutral mechanical range and 8-year survivorship of the primary or post-traumatic group [12]. Thus, it might be equally important to consider the factors of component rotation, ligament balance, restoration of the joint line, the soft-tissue condition, the implant choice and rehabilitation.

The current evidence has shown that overall, TKR is an effective procedure for severe pain and disability in patients with both primary and post-traumatic knee OA. Some patients will feel there is a benefit in terms of pain and physical function. But, TKR is typically more technically challenging when it comes to dealing with PTOA due to the

fact that previous surgery, retained implants, scarring, bone loss, instability, and altered anatomy are all factors that need to be considered.
There have been mixed data reported about the function and the complication rates in PTOA, while other studies have shown similar results to primary OA, especially in patients who had developed arthritis following a ligamentous injury and without fracture. The inconsistent results could be attributed to variation in sample size, nature of trauma, methods of assessment, implant used, length of follow-up, rehabilitation and surgical technique.
Previous studies have tended to concentrate on postoperative complications, implant survival, or the final functional scores. There are few studies which directly compare pre and post VAS scores and WOMAC scores, and the extent to which these scores change, between patients with primary OA and PTOA. It is necessary to compare both end values and the changes from baseline as two groups may have the same postoperative score, but different changes from baseline. Additional comparative studies are thus needed to see if the cause of the knee OA has an independent impact on pain relief and functional recovery post-TKR. These may help to inform more accurate patient counselling, better surgical planning, the correct implant choice and individualized postoperative rehabilitation.

3.1: OBJECTIVE(S)
To compare functional outcomes, and complications of total knee replacement in post-traumatic osteoarthritis v/s primary knee osteoarthritis.

3.2: RATIONALE
Post traumatic arthritis is often complicated by surgery, and might have a previous fracture, ligament injury, malalignment or retained hardware at a younger age. Further, there is little data that compares the comorbidities, functional outcomes, complications, and long-term implant survivorship of fracture-related and ligamentous post traumatic osteoarthritis (PTOA) to primary OA. Thus, the present study was designed to assess if postoperative mechanical axis alignment is associated with compare comorbidities, functional outcomes and complication survival following Total Knee Replacement.

3.3: OPERATIONAL DEFINITION(S)
1. Osteoarthritis (OA)
Osteoarthritis (OA) is a chronic and progressive degenerative disease of synovial joints, in which the cartilage covering the joints undergoes gradual loss followed by remodeling of the underlying subchondral bone, formation of osteophytes, synovial inflammation, and loss of physical function, along with pain and stiffness. For the purposes of the current study, OA is specifically defined as those patients who were clinically and radiographically diagnosed with knee OA by an orthopedic surgeon and had a total knee replacement (TKR) performed.
2. Primary Knee Osteoarthritis (Primary OA)
Primary knee osteoarthritis can be defined as a degenerative arthritis of the knee that occurs in the absence of any traumatic, inflammatory, congenital or metabolic cause. It is believed to be an age related disorder due to progressive degeneration of the joint cartilage. For this study, patients with primary OA were those who did not have a significant history of knee trauma in which they developed OA.
3. Total Knee Replacement (TKR)
Total Knee Replacement (TKR) or Total Knee Arthroplasty (TKA) is a surgical procedure where the damaged surfaces of the femur, tibia and (if necessary) the patella are replaced with artificial components. The goal of the procedure is to alleviate pain, restore joint function, increase mobility, and improve patients' quality of life for those with an advanced knee joint condition of arthritis. This was a study of all patients who had primary TKR for symptomatic knee OA.

4. Pain

Pain is an unpleasant sensory and emotional experience related to actual or potential tissue damage. In this study, the Visual Analog Scale (VAS) will be used to assess knee pain, with a rating of 0 indicating no pain and 10 indicating the worst pain imaginable. Preoperative and postoperative pain scores were obtained to determine the improvement after TKR.

5. Visual Analog Scale (VAS)

Visual Analog Scale (VAS) is a subjective instrument that has been validated for the measurement of the intensity of pain. It is made up of a numerical scale from 0 (no pain) to 10 (the worst possible pain). Patients pick the number which is the best description of the intensity of their knee pain at the time of assessment. In the present study, the VAS scores are used to compare pre and postsurgical pain in patients who received a TKA.

6. WOMAC Score

The Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) is a standardized, disease-specific questionnaire to assess symptoms and functional limitation in patients with hip and knee osteoarthritis. It is composed of 24 items, in three subscales:

- Pain (5 items)
- Stiffness (2 items)
- Physical Function (17 items)

All subscales are transformed into a 0–100 scale with 0 indicating a maximum disability and 100 indicating no disability. In this study, WOMAC scores are used to measure the clinical outcome of patients pre and post total knee replacement.

7. Pain Subscale (WOMAC Pain)

The WOMAC Pain subscale is used to assess pain during five activities of daily living: walking on a flat surface, climbing stairs, resting in bed, sitting or lying down and standing up. The higher the score after surgery, the less pain and the better the clinical result.

8. Stiffness

Stiffness in the knee joint is characterized by feeling that the knee lacks movement and the ability to move the knee joint freely, especially after rest or in the morning. Stiffness is assessed in this study by the WOMAC stiffness subscale which consists of 2 items, higher scores indicating less stiffness, and better joint mobility.

9. Physical Function

Physical function is the patient's capacity for activities of daily living (walking, climbing stairs, getting up out of a chair, standing, bending, shopping, etc.). Functional ability is assessed with the 17 item WOMAC Physical Function subscale, where higher scores reflect higher functional ability and less disability.

10. Functional Outcome

Functional outcome is the improvement in pain relief, joint stiffness and physical function after total knee replacement surgery. Functional outcome is defined by WOMAC and VAS scores obtained at follow-up comparing preoperative and postoperative scores.

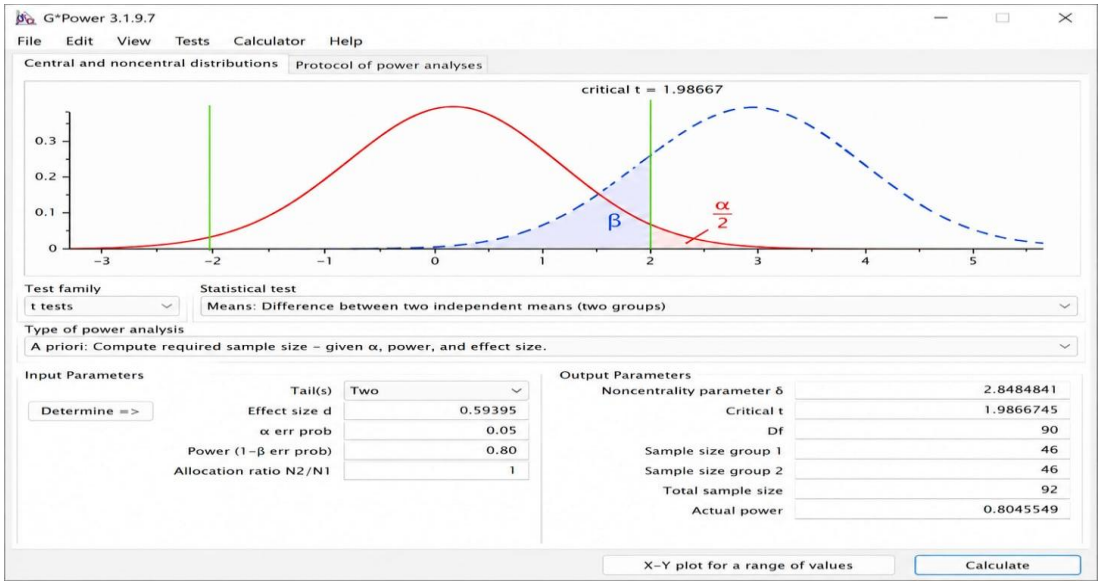
MATERIAL AND METHODS

4.1: Study Design: It was comparative study.

4.2: Settings: Data was collected from social security hospital Multan road

4.3: Study Duration: The duration of this study was 4 Months after the approval of synopsis from the Departmental Research Committee.

4.4: Sample Size: The sample size of our comparative study was 92



4.5: Sampling Technique: Purposive Sampling Technique.

4.6: Sample Selection: A total of 92 patients were selected through purposive sampling according to the inclusion and exclusion criteria. Demographic, clinical, VAS, WOMAC, and postoperative complication data were collected using a structured proforma.

4.6.1: Inclusion Criteria:

- Patients undergoing total knee replacement for primary knee osteoarthritis or posttraumatic osteoarthritis caused by knee fracture or ligamentous injury.
- Total knee replacement with patellar resurfacing performed

4.6.2: Exclusion Criteria:

- Osteoarthritis Secondary due to non-traumatic causes (e.g., rheumatoid arthritis, osteonecrosis, septic arthritis).
- Patients with follow-up.

4.8: ETHICAL CONSIDERATIONS

Ethical guidelines of University of Lahore were followed throughout the execution of this research to protect the rights and well-being of the participants. The study was commenced after obtaining ethical approval from the relevant Ethical Review Committee (ERC)/Institutional Review Board (IRB) of the University of Lahore.

- All the participants signed a written informed consent before entering the study.
- Confidentiality of all information gathered from the participants was maintained and only used for research purposes.
- No personal identifiers were revealed and the identity of all the participants remained anonymous during the study.
- Participants were told that participation in the study was completely voluntary.
- Participants were informed that there were no foreseen risks or disadvantages to participating in the study.
- Participants were told that they had the right to refuse to participate as well as to withdraw from the study at any time without any penalty or impact on their treatment.
- All data collected were kept safe under a lock and key and electronic data were kept on the researchers' laptop and password protected. The data was only accessible to the researcher and supervisor.

The study followed the ethical guidelines of the Declaration of Helsinki to maintain respect for the human participants, confidentiality and research integrity.

4.9: DATA COLLECTION PROCEDURE

Data Collection Procedure

Following IRB approval, patients' medical records were reviewed retrospectively for patients who underwent Total Knee Replacement (TKR) from January 2006 to December 2012 at the Adult Reconstruction Center. Relevant demographic, clinical, perioperative, radiographic and postoperative data were extracted from the hospital database by using a structured data collection form. Patients were screened based on the inclusion and exclusion criteria. 852 eligible patients were included and divided into three groups (Primary OA, Fracture PTOA, and Ligamentous PTOA) according to knee OA etiology.

Collected variables were age, gender, body mass index (BMI), smoking, alcohol consumption, comorbidities, American Society of Anesthesiologists (ASA) classification, Charlson Comorbidity Index (CCI), operative time, blood lost during operation, hospital stay, preoperative and postoperative Visual Analog Scale (VAS) pain scores, and Western Ontario and McMaster Universities Osteoarthritis Index (WOMAC) scores. Postoperative mechanical axis alignment and posterior tibial slope were also obtained from standing hip-to-ankle radiographs, if available. Also, during the follow-up period postoperative complications, readmissions, revision surgeries and implant survivorship were recorded. Patients had been prospectively filled out the WOMAC and VAS questionnaires during the follow-up visit that is part of normal clinical practice. All the data retrieved were checked for completeness and correctness before subjected to statistical analysis in the study data base.

4.10: DATA ANALYSIS PROCEDURE:

SPSS 27.0 statistical software was used for data analysis. Descriptive statistics (frequencies, percentages, bar graphs, and pie charts) and inferential statistics (such as t-test, chi squares, etc.) will be used in the analysis of the data.

RESULTS

Functional Outcomes and Complications of Total Knee Replacement in Post-Traumatic and Primary Osteoarthritis

The statistical results of 92 patients with total knee replacement is presented. There were 46 patients in each group: 46 patients with post-traumatic osteoarthritis (PTOA) and 46 patients with primary osteoarthritis (POA). Data for continuous variables and outcome scores are expressed as mean standard deviation (SD) and data for categorical variables are expressed as frequencies, n (%). Preoperative score and postoperative score within each group were compared using paired t-tests and respective paired p-values are given. Statistically significant differences were set at a p value of < 0.05.

Table 5.1A: Continuous Demographic and Baseline Clinical Characteristics (Mean ± SD)

Variable	PTOA Mean ± SD	POA Mean ± SD	p-value
Age, years	55.63 ± 11.00	64.61 ± 7.74	**<0.001**
Body mass index, kg/m²	29.28 ± 4.29	31.04 ± 4.29	0.053
Duration of symptoms, years	7.52 ± 3.24	5.90 ± 2.45	**0.009**

PTOA patients were significantly younger and had a longer symptom duration than POA patients ($p<0.001$ and $p=0.009$). BMI did not differ significantly ($p=0.053$).

Table 5.1B: Categorical Demographic and Baseline Clinical Characteristics (Frequency, n (%))

Variable	PTOA Frequency, n (%)	POA Frequency, n (%)	p-value
Gender: male	25 (54.3%)	22 (47.8%)	0.532
Gender: female	21 (45.7%)	24 (52.2%)	0.532
Smoking history: yes	4 (8.7%)	3 (6.5%)	1.000
Alcohol consumption: yes	17 (37.0%)	14 (30.4%)	0.508
Any chronic disease	35 (76.1%)	41 (89.1%)	0.099
Diabetes mellitus	6 (13.0%)	19 (41.3%)	**0.002**
Hypertension	20 (43.5%)	27 (58.7%)	0.144
Heart disease	6 (13.0%)	8 (17.4%)	0.562
Lung disease	3 (6.5%)	6 (13.0%)	0.485
Kidney disease	1 (2.2%)	4 (8.7%)	0.361
Other chronic disease	4 (8.7%)	2 (4.3%)	0.677
Anticoagulant use	6 (13.0%)	15 (32.6%)	**0.025**
ASA class III or above	5 (10.9%)	15 (32.6%)	**0.011**

Diabetes mellitus, anticoagulant use, and ASA class III or above were significantly more frequent in POA (all $p<0.05$). Other categorical characteristics were comparable.

5.2A: Preoperative and Postoperative VAS and WOMAC Scores in the PTOA Group (n=46)

Outcome (scale)	Preoperative Mean ± SD	Postoperative Mean ± SD	Paired p-value
VAS pain (0-10)	8.17 ± 1.06	1.78 ± 1.13	**<0.001**
Total WOMAC (0-96)	79.59 ± 6.09	33.61 ± 8.45	**<0.001**
WOMAC pain (0-20)	16.63 ± 1.70	5.35 ± 3.89	**<0.001**
WOMAC stiffness (0-8)	6.59 ± 0.98	3.15 ± 1.48	**<0.001**
WOMAC function (0-68)	56.37 ± 4.87	25.11 ± 6.81	**<0.001**

In the PTOA group, VAS pain and all WOMAC scores decreased significantly after total knee replacement (all paired $p<0.001$). This indicates marked pain relief and functional improvement.

Table 5.2B: Preoperative and Postoperative VAS and WOMAC Scores in the POA Group (n=46)

Outcome (scale)	Preoperative Mean ± SD	Postoperative Mean ± SD	Paired p-value
VAS pain (0-10)	7.78 ± 1.07	1.37 ± 1.16	**<0.001**
Total WOMAC (0-96)	79.65 ± 4.42	30.67 ± 6.48	**<0.001**
WOMAC pain (0-20)	16.35 ± 1.64	4.37 ± 3.56	**<0.001**
WOMAC stiffness (0-8)	6.63 ± 1.02	2.76 ± 1.42	**<0.001**
WOMAC function (0-68)	56.67 ± 3.77	23.54 ± 5.21	**<0.001**

In the POA group, VAS pain and all WOMAC scores decreased significantly after total knee replacement (all paired $p<0.001$). This indicates marked pain relief and functional improvement.

Table 5.3A: Improvement in VAS and WOMAC Scores in the PTOA Group (n=46)

Outcome (scale)	Improvement Mean ± SD	Between-group p-value (PTOA vs POA)
VAS pain (0-10)	6.39 ± 1.54	0.947
Total WOMAC (0-96)	45.98 ± 6.29	**0.025***
WOMAC pain (0-20)	11.28 ± 3.58	0.361
WOMAC stiffness (0-8)	3.43 ± 1.07	0.054
WOMAC function (0-68)	31.26 ± 5.38	0.062

The PTOA group showed substantial improvement in VAS pain and all WOMAC domains. Between-group analysis was significant only for total WOMAC improvement (p=0.025), favoring POA.

Table 5.3B: Improvement in VAS and WOMAC Scores in the POA Group (n=46)

Outcome (scale)	Improvement Mean ± SD	Between-group p-value (PTOA vs POA)
VAS pain (0-10)	6.41 ± 1.57	0.947
Total WOMAC (0-96)	48.98 ± 6.36	**0.025***
WOMAC pain (0-20)	11.98 ± 3.70	0.361
WOMAC stiffness (0-8)	3.87 ± 1.07	0.054
WOMAC function (0-68)	33.13 ± 4.01	0.062

The POA group showed substantial improvement in all outcomes. Total WOMAC improvement was greater than in PTOA (48.98 vs 45.98; p=0.025), while other improvements were comparable.

Table 5.4: Postoperative Complications (Frequency, n (%))

Complication	PTOA Frequency, n (%)	POA Frequency, n (%)	p-value
Surgical-site/wound infection	5 (10.9%)	1 (2.2%)	0.203
Urinary tract infection	2 (4.3%)	2 (4.3%)	1.000
DVT/PE	1 (2.2%)	1 (2.2%)	1.000
Readmission within 30 days	0 (0.0%)	1 (2.2%)	1.000
Readmission between 30 and 90 days	1 (2.2%)	3 (6.5%)	0.617
Revision surgery	1 (2.2%)	0 (0.0%)	1.000
Other postoperative complication	2 (4.3%)	2 (4.3%)	1.000
Any postoperative event	11 (23.9%)	7 (15.2%)	0.293

Interpretation

Overall postoperative events were more frequent in PTOA than POA (23.9% vs 15.2%), but the difference was not significant (p=0.293). No individual complication differed significantly.

DISCUSSION

The present study aimed to compare the functional outcome and postoperative complications in patients with post-traumatic osteoarthritis undergoing total knee replacement (TKR) with those of primary osteoarthritis patients undergoing TKR. The total number of patients was 92, with 46 patients in each group. The major findings were that patients with post-traumatic osteoarthritis had a younger age and a longer duration of symptoms, while patients with primary osteoarthritis had a higher burden of diabetes mellitus, anticoagulant use, and higher American Society of Anesthesiologists classification. Both groups experienced significant improvement in pain and knee function with total knee replacement. Most post-op VAS and WOMAC results were similar; the only difference was that the total WOMAC improvement was significantly higher in the primary osteoarthritis group. Even though there were more events numerically in the post-traumatic group, overall complication rate or any single complication was not significantly different between groups.

One key finding was that patients with post-traumatic osteoarthritis were significantly younger than those with primary osteoarthritis. The mean age in post-traumatic group was 55.63 years and 64.61 years in primary group. This is to be expected clinically, as post-traumatic OA occurs when the knee suffers a trauma, such as a fracture, ligament injury, meniscal injury or other damage, and can therefore progress to end-stage disease at a younger age. Mason, Englund and Watt also described how, in fact, post-traumatic osteoarthritis often occurs in younger, more active people than primary arthritis. Primary osteoarthritis, on the contrary, is strongly linked to ageing and progressive degenerative changes, which might account for the older age of the patients in the primary osteoarthritis group [1,2].

There was also a significant difference in the length of the symptoms in the post-traumatic osteoarthritis group. The average duration of symptoms in these patients is 7.52 years, while for the primary osteoarthritis patients it is 5.90 years. Chronic cartilage breakdown, inflammation, joint loading changes, deformity, and gradual functional loss can start with prior trauma, before the need for a total knee replacement. Patients can also have surgeries like fracture fixation, ligament reconstruction, implant removal or corrective surgery prior to arthroplasty. So the extended symptomatic period seen in the present study might represent the complicated and slow course of joint

degeneration following trauma. This is in line with the known natural history of post-traumatic osteoarthritis, as previously reported in the literature.

The two groups were not statistically different in regard to gender, smoking history, alcohol consumption, and most chronic diseases. The likeness of these characteristics created a more comparable study groups as large differences in lifestyle and general health may otherwise affect pain, recovery, wound healing, and postoperative function. There was a non-statistically significant difference in body mass index between the primary osteoarthritis group and the other group. The p value of 0.053 indicated a possible trend but this was not considered to be a statistically proven difference. Obesity is a known risk factor for primary knee OA as it leads to increased mechanical loading and potentially also affects via metabolic and inflammatory pathways .

Patients primary osteoarthritis had significantly higher prevalence of diabetes mellitus. Also, the use of anticoagulants and ASA class III or higher were significantly more common in this group. These results might be partially explained by the higher mean age in the group of patients with primary osteoarthritis. Older patients are more likely to have metabolic and cardiovascular disease that will need long-term management, such as anticoagulant therapy. A higher proportion of ASA class III or more, implies that the primary osteoarthritis group suffered a higher medical burden prior to surgery. Such differences are significant as there may be implications for perioperative risk, rehabilitation, and wound healing in patients with diabetes or taking anticoagulants, and general health status. However, the overall improvement in function was slightly better in the primary osteoarthritis group, reflecting the effectiveness of total knee replacement (TKA) in correctly selected older patients despite the higher burden of medical problems.

One of the most important outcomes measured in the present study was pain relief. Preoperatively, pain was severe in both groups with a mean VAS score of 8.17 in post-traumatic osteoarthritis and 7.78 in primary osteoarthritis. The difference was not significant and this showed that both groups had a similar level of pain in the pre-operative period. The high pain scores preoperatively also confirm that the patients had advanced symptomatic disease and were suitable for total knee replacement following conservative treatment failure. Both types of osteoarthritis can cause severe pain due to loss of cartilage, exposed subchondral bone, inflammation, deformity and mechanical blockage of the joint.

The mean VAS pain score after TKA was 1.78 in the post-traumatic group and 1.37 in the primary group. VAS improvement was almost the same, (6.39 points and 6.41 points respectively). No statistical difference was found between postoperative pain levels or the improvement in pain levels between groups. These results showed that TKR was effective in reducing pain both in those with primary and those with post-traumatic osteoarthritis. Phruetthiphat et al also showed that patients with post-traumatic osteoarthritis can get significant pain relief from total knee arthroplasty despite the higher surgical technical difficulty [6].

The comparable improvement in VAS pain is clinically relevant as patients with post-traumatic osteoarthritis may be expected to have more scar tissue, altered anatomy, previous surgical exposure, retained implants or ligament imbalance. While these factors may be an issue that makes it difficult to perform the operation, they did not hinder the ability to achieve major postoperative pain reduction in this study. All sorts of factors contribute to pain after total knee replacement, including the correction of deformity, restoration of alignment, removal of damaged joint surfaces, rehabilitation and individual pain perception. Thus, the findings indicate that total knee replacement well managed with a proper plan can be effective in pain control in both the groups.

The total WOMAC scores preoperatively were nearly the same in both groups and showed comparable baseline severity of pain, stiffness and physical limitation. Total WOMAC scores were lower in both groups after surgery, representing significant clinical improvement after surgery. A slight decrease in the postoperative score was

seen in the primary osteoarthritis group, but this was not significant. These results are in line with the known effects of TKA on mobility, activities of daily living, and health-related QOL in patients with end-stage knee OA.

There was only one statistically significant between-group difference in any of the primary functional outcome measures: total WOMAC improvement. The improvements in the post-traumatic (mean 45.98) and primary osteoarthritis (mean 48.98) groups were comparable. This is an indicator finding which shows that both groups have reached a significant improvement but the improvement is around 3 points higher in primary osteoarthritis. The results are comparable as described in literature, in which patients with total knee replacement for post-traumatic osteoarthritis have meaningful improvements, but slightly less predictable functional recovery when compared with patients with primary osteoarthritis.

The relatively smaller total WOMAC improvement in the post-traumatic osteoarthritis might be due to the complexity of the condition and not due to failure of the replacement itself. Old fractures can result in malunion, bone loss, deformity and abnormal joint lines. Scarring in the soft tissues, loss of vascularity, stiffness and imbalance of the collateral ligaments are all potential effects of previous operations. Long-term abnormal movements or muscle weakness may also persist following correction of the articular surface. Even if pain can be resolved, these may prevent full functional recovery. Hence, post-traumatic OA patients should be informed that their function will improve significantly after surgery, but it may not be as good as in cases of uncomplicated primary OA.

There was no difference between the groups in pain, stiffness or physical function on the WOMAC subdomains. There was similar improvement in WOMAC pain score, thus supporting the VAS findings and confirming that the pain relief in both groups was substantial. WOMAC stiffness improvement was slightly higher in primary osteoarthritis, but the p-value was 0.054 which was slightly higher than the accepted significance level. Similarly, the function improvement on the WOMAC was in favor of the primary group, however, this was not statistically significant (p-value 0.062). Total WOMAC improvement was significant, which may have been caused by these near-significant trends, acting together.

The results with regard to stiffness and function should be interpreted with caution. The non-significant p value does NOT mean that the two groups are exactly the same, it only means that the difference observed was not great enough to rule out chance at the chosen level of significance. The post-traumatic group might need longer and more individually tailored rehab as previous injury, immobilization, scar formation, muscle weakness can restrict range of motion. Early mobilization, physiotherapy and quadriceps strengthening and realistic functional targets are therefore especially critical in these patients. The statistical power in a larger study may be sufficient to assess whether the differences in both stiffness and function are clinically significant.

Overall, there were no significant differences in postoperative safety outcomes. Post-op events occurred in 23.9% of those with post-traumatic osteoarthritis and 15.2% of those with primary osteoarthritis. The percentage was greater in the post-traumatic group but not significant. In their study, Syrikas et al. showed that the total knee replacement for post-traumatic osteoarthritis might have a higher complication rate and more difficult surgery than for primary osteoarthritis [7]. The numerical pattern seen in the present study agrees with this concern but the sample failed to show a statistically confirmed difference.

Five patients with post-traumatic OA and one with primary OA developed surgical-site or wound infection. This was the biggest absolute difference of one of the individual complications, although it was not statistically significant. Previously injured areas or surgery may affect the soft-tissue envelope, local blood supply and add to the dissection, potentially contributing to wound issues. It is, however, not possible to draw the present results into the question of whether infected post-traumatic osteoarthritis is a primary

infection or not. Urinary tract infection and DVT and pulmonary embolism incidences were comparable between the groups and readmission and revision events were rare. None of the individual postoperative complications were significantly different.
The lack of significant differences in complications is reassuring and implies that total knee replacement can be conducted safely in both patient groups provided that they are adequately assessed and managed. However, the small number of individual events precludes a more definitive conclusion. If an outcome is rare, then larger samples are needed to be able to determine the meaningful differences between groups. It should not be concluded, however, that the surgical complexity of post-traumatic osteoarthritis is not important based on the findings. Pre-operative careful imaging, evaluation of the previous scars and implants, evaluation of ligament stability, screening for infection if indicated, and the availability of specialized implants are still important in post-traumatic cases [6,7].
The current results are of clinical relevance for patient advice and surgical decision making. Patients with primary and post-traumatic osteoarthritis can be told that total knee replacement will likely result in significant improvement in function and pain. Post-traumatic disease patients should also be aware that the disease may be more complicated and the overall functional improvement slightly less than a primary osteoarthritis patient. In contrast, the older age and higher medical load of patients in the primary osteoarthritis group suggests that an optimization of the diabetes, anticoagulants, cardiovascular risk and antiesthetic status prior to surgery is required.
There are a number of strengths to the current research. There were equal numbers of patients in the two groups, thus a direct comparison could be made between post-traumatic and primary osteoarthritis. Patient-reported measures used to assess pain and function were recognized ones, such as the VAS and WOMAC scores. Preoperative scores, postoperative scores and improvement scores were analysed separately, which allowed detailed analysis of the treatment response. Moreover, various post-operative complications were assessed, which permitted considering effectiveness as well as safety. The statistical comparison was further solidified by the use of appropriate independent-samples, chi-square and Fisher exact tests.
There were also limitations to the study. The relatively small number of patients studied (n = 92) was sufficient to detect several differences in continuous outcomes but was too small for comparison of uncommon postoperative complications. The low event numbers led to low statistical power and a number of p-values of 1.000 where the frequencies were equal or very low. Occupational status, laterality of the involved knees were not available, and other factors that may have influenced the results, including the original traumatic injury, previous surgeries, retained implants, deformity, surgical time, implant fixation, rehabilitation compliance, and follow-up period were not considered. The possibility that baseline age, diabetes, use of anticoagulants or ASA classification had an effect on the outcomes could also be influential, and both of these factors could be identified by adjusted multivariable analyses.
Larger, preferably multicenter, samples with longer follow-up periods are needed to look at implant survival, late infection, revision surgery, range of motion, patient satisfaction and quality of life in future studies. Additionally, stratifying the groups by type of prior trauma and surgery will highlight which post-traumatic patients are most likely to have poorer outcomes. Nevertheless, the current study offers valuable information that both total knee replacement is effective in both conditions. The over-all results show significant and similar pain reduction with a small difference in favour of total WOMAC improvement in primary OA. Postoperative events were more numerous in post-traumatic osteoarthritis, but were not found to be statistically different.

7.1: CONCLUSION(S)

Total knee replacement resulted in significant decrease of pain and in clinically important improvement of knee function, in both patients with post-traumatic and

patients with primary OA. Preoperative and postoperative VAS and WOMAC outcomes were similar for both groups. But the overall improvement in WOMAC was significantly higher in patients who had primary osteoarthritis. Diabetes, anticoagulant use and higher ASA class were more prevalent in the primary osteoarthritis group, whereas patients with post-traumatic osteoarthritis were younger and had longer duration of symptoms. The number of postoperative complications were higher in post-traumatic group, though the differences were not statistically significant. Overall, both groups had an effective and relatively safe TKA treatment.

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7.2: RECOMMENDATIONS

- Future research should be done with a larger sample size to make the results more reliable and generalizable.
- It is recommended to have multicenter studies involving hospitals from different regions of Punjab and Pakistan to get more representative results.
- The long-term follow-up should be performed to assess pain relief, functional recovery, implant survival, patient satisfaction, reoperation rates, and postoperative complications after total knee replacement.
- • Future studies should be directed towards recognizing the causes of the relative lesser WOMAC improvement noted in patients with post-traumatic osteoarthritis.

7.3: LIMITATIONS

- The sample size of the study was relatively small (92 patients), and the findings may not be generalizable.
- The study was conducted in one healthcare setting and may not be applicable to patients in other hospitals or areas of Pakistan.
- The results of the postoperative period might have been affected by significant differences at baseline in age, duration of symptoms, diabetes mellitus, use of anticoagulants, and ASA classification.
- Pain and functional recovery might have been influenced by differences in surgeon experience, operative technique, prosthesis used, and postoperative rehabilitation.
- The patient reported VAS and WOMAC which may have been influenced by individual pain perception, expectations, and compliance.
- The follow-up time was too short to evaluate long-term implant survival, late complications, revision surgery, or functional improvement over the long-term.

REFERENCES

Hunter DJ, Bierma-Zeinstra S. Osteoarthritis. Lancet. 2019;393(10182):1745-59. doi:10.1016/S0140-6736(19)30417-9.

Katz JN, Arant KR, Loeser RF. Diagnosis and treatment of hip and knee osteoarthritis: a review. JAMA. 2021;325(6):568-78. doi:10.1001/jama.2020.22171.

Brown TD, Johnston RC, Saltzman CL, Marsh JL, Buckwalter JA. Post-traumatic osteoarthritis: a first estimate of incidence, prevalence, and burden of disease. J Orthop Trauma. 2006;20(10):739-44. doi:10.1097/01.bot.0000246468.80635.ef.

Punzi L, Galozzi P, Luisetto R, Favero M, Ramonda R, Oliviero F, et al. Post-traumatic arthritis: overview on pathogenic mechanisms and role of inflammation. RMD Open. 2016;2(2):e000279. doi:10.1136/rmdopen-2016-000279.

Anderson DD, Chubinskaya S, Guilak F, Martin JA, Oegema TR Jr, Olson SA, et al. Post-traumatic osteoarthritis: improved understanding and opportunities for early intervention. J Orthop Res. 2011;29(6):802-9. doi:10.1002/jor.21359.

Kolasinski SL, Neogi T, Hochberg MC, Oatis C, Guyatt G, Block J, et al. 2019 American College of Rheumatology/Arthritis Foundation guideline for the

management of osteoarthritis of the hand, hip, and knee. Arthritis Care Res (Hoboken). 2020;72(2):149-62. doi:10.1002/acr.24131.
Evans JT, Walker RW, Evans JP, Blom AW, Sayers A, Whitehouse MR. How long does a knee replacement last? A systematic review and meta-analysis of case series and national registry reports with more than 15 years of follow-up. Lancet. 2019;393(10172):655-63. doi:10.1016/S0140-6736(18)32531-5.
Dexel J, Beyer F, Lützner C, Kleber C, Lützner J. TKA for posttraumatic osteoarthritis is more complex and needs more surgical resources. Orthopedics. 2016;39(3 Suppl):S36-40.
Phruetthiphat O, Zampogna B, Vasta S, Tassanawipas B, Gao Y, Callaghan JJ. TKR after posttraumatic and primary knee osteoarthritis: a comparative study. J Orthop Surg Res. 2021;16:173. doi:10.1186/s13018-021-02322-8.
Honkonen SE. Degenerative arthritis after tibial plateau fractures. J Orthop Trauma. 1995;9(4):273-7. doi:10.1097/00005131-199509040-00001.
Volpin G, Dowd GS, Stein H, Bentley G. Degenerative arthritis after intra-articular fractures of the knee: long-term results. J Bone Joint Surg Br. 1990;72(4):634-8.
Stevens DG, Beharry R, McKee MD, Waddell JP, Schemitsch EH. The long-term functional outcome of operatively treated tibial plateau fractures. J Orthop Trauma. 2001;15(5):312-20. doi:10.1097/00005131-200106000-00002.
Wasserstein D, Henry P, Paterson JM, Kreder HJ, Jenkinson R. Risk of total knee arthroplasty after operatively treated tibial plateau fracture: a matched population-based cohort study. J Bone Joint Surg Am. 2014;96(2):144-50. doi:10.2106/JBJS.L.01691.
Lunebourg A, Parratte S, Gay A, Ollivier M, Garcia-Parra K, Argenson JN. Lower function, quality of life, and survival rate after total knee arthroplasty for posttraumatic arthritis than for primary arthritis. Acta Orthop. 2015;86(2):189-94.
Brockman BS, Maupin JJ, Thompson SF, Hollabaugh KM, Thakral R. Complication rates in total knee arthroplasty performed for osteoarthritis and post-traumatic arthritis: a comparison study. J Arthroplasty. 2020;35(2):371-4. doi:10.1016/j.arth.2019.09.022.
Bala A, Penrose CT, Seyler TM, Mather RC III, Wellman SS, Bolognesi MP. Outcomes after total knee arthroplasty for post-traumatic arthritis. Knee. 2015;22(6):630-9. doi:10.1016/j.knee.2015.10.004.
Bellamy N, Buchanan WW, Goldsmith CH, Campbell J, Stitt LW. Validation study of WOMAC: a health-status instrument for measuring clinically important patient-relevant outcomes to antirheumatic drug therapy in patients with osteoarthritis of the hip or knee. J Rheumatol. 1988;15(12):1833-40.
Baron G, Tubach F, Ravaud P, Logeart I, Dougados M. Validation of a short form of the Western Ontario and McMaster Universities Osteoarthritis Index function subscale in hip and knee osteoarthritis. Arthritis Rheum. 2007;57(4):633-8. doi:10.1002/art.22685.
Saleh KJ, Sherman P, Katkin P, Windsor R, Haas S, Laskin R. Total knee arthroplasty after open reduction and internal fixation of fractures of the tibial plateau. J Bone Joint Surg Am. 2001;83(8):1144-8.
Parratte S, Pagnano MW, Trousdale RT, Berry DJ. Effect of postoperative mechanical-axis alignment on the fifteen-year survival of modern, cemented total knee replacements. J Bone Joint Surg Am. 2010;92(12):2143-9.
Bonner TJ, Eardley WGP, Patterson P, Gregg PJ. The effect of postoperative mechanical-axis alignment on the survival of primary total knee replacements after a follow-up of 15 years. J Bone Joint Surg Br. 2011;93-B(9):1217-22.